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Electrical Power Subsystem (EPS) Fuel Cells and Power Distribution Malfunction Symptoms - September 15, 1967 Group

National Aeronautics and Space Administration (NASA)

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SWIGERT
11/13/67

APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p><i>initial review 11/15/67</i></p> <p><i>WAS removed 12/5/67</i></p> <p><i>low about just 226V</i></p> <p><i>c/w failure not including</i></p> <p><i>assigned format</i></p> <p><i>12/8</i></p> <p><i>Hardy to write FIC Bus disconnect</i></p>	<p>1 RESET & EDG 512</p> <p><i>initially MW 512 A(B) RESET RESET (several times) MONITORING</i></p> <p>YES → 2 TRANSIENT UNDERVOLT</p> <p>NO → 3 REPEAT RESET ATTEMPT</p> <p><i>initially MW 512 A(B) RESET RESET (several times) MONITORING</i></p> <p>YES → 4 IDENTIFY TRANSIENT UNDERVOLT</p> <p>NO → 5 TURN OFF SERIAL</p> <p><i>initially MW 512 A(B) RESET RESET (several times) MONITORING</i></p> <p>YES → 6 DC UNDERVOLT</p> <p>NO → 7 C/W FAILURE</p> <p>8 LIGHT ST-DC VOLT 72?</p> <p>YES → 9 TRANSIENT OVERLOAD</p> <p>NO → 10 FIC</p> <p>11 FIC 5/1</p> <p>12 CONTINUOUS OVERLOAD</p> <p>13 Attempt isolation of overload by individually opening C&A on affected bus</p>	<p><i>Handwritten notes in Remarks column:</i></p> <p><i>MU Bus UNDERVOLT Light ON IF</i></p> <p><i>1. LOSS OF SUBSEQUENT INDICATION OF MAIN BUS A(B) FAILURE OR BUS TRANSITION INDICATION</i></p> <p><i>Monitor on voltmeter bus with faulty undervolt sensor.</i></p> <p><i>Survey C&A panel for change of number</i></p> <p><i>full bus being used will indicate (and any amount of power)</i></p>

G&N	MALFUNCTION
SCS	MALFUNCTION
SPS	MALFUNCTION
RCS	MALFUNCTION
EPS	MALFUNCTION
T/C	MALFUNCTION
ECS	MALFUNCTION
SEQ	MALFUNCTION

APOLLO OPERATIONS HANDBOOK

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**G&N
MALFUNCTION**

SCS MALFUNCTION

SPS
MALFUNCTION

RCS MALFUNCTION

EPS MALFUNCTION

T/C
WALFUNCTION

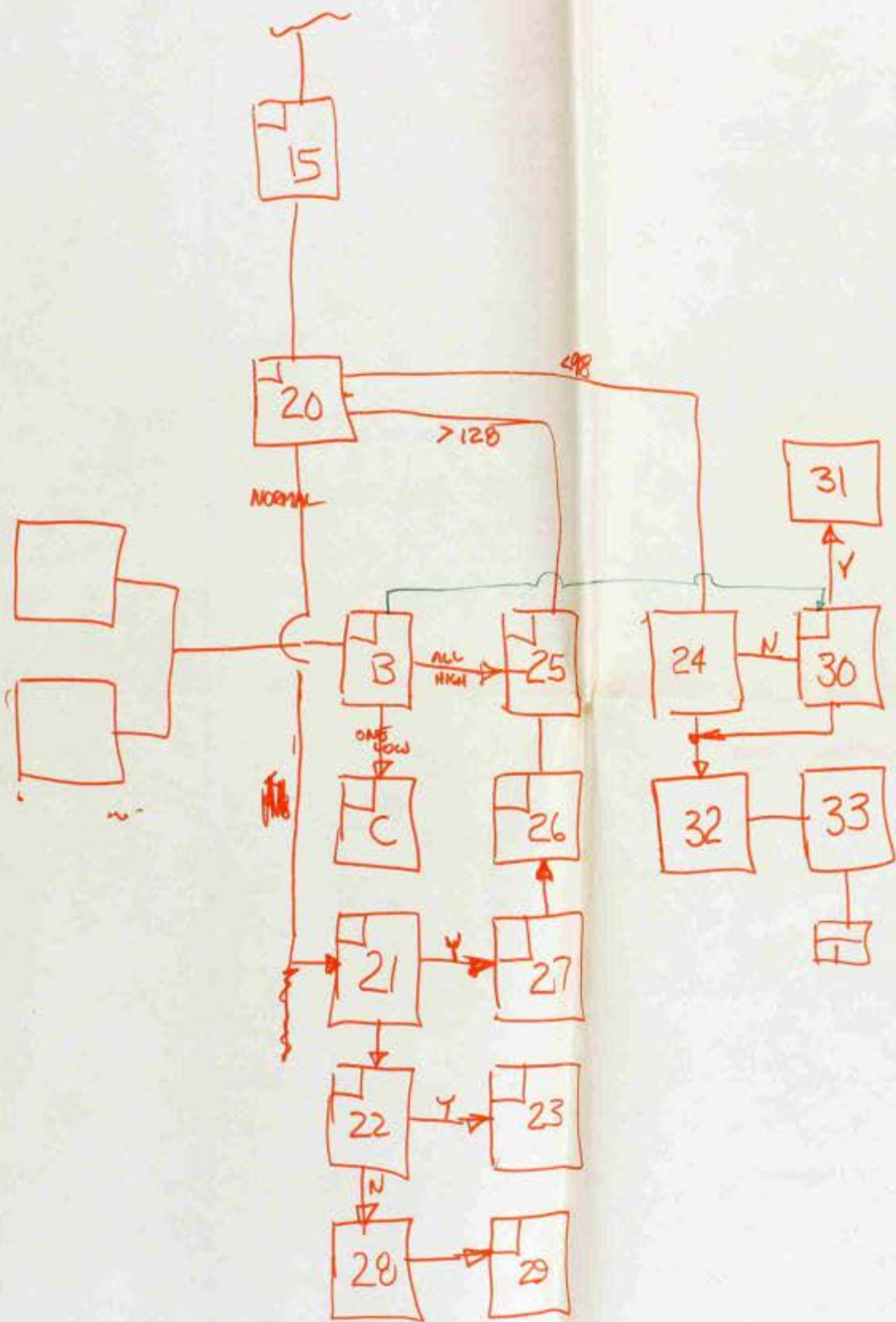
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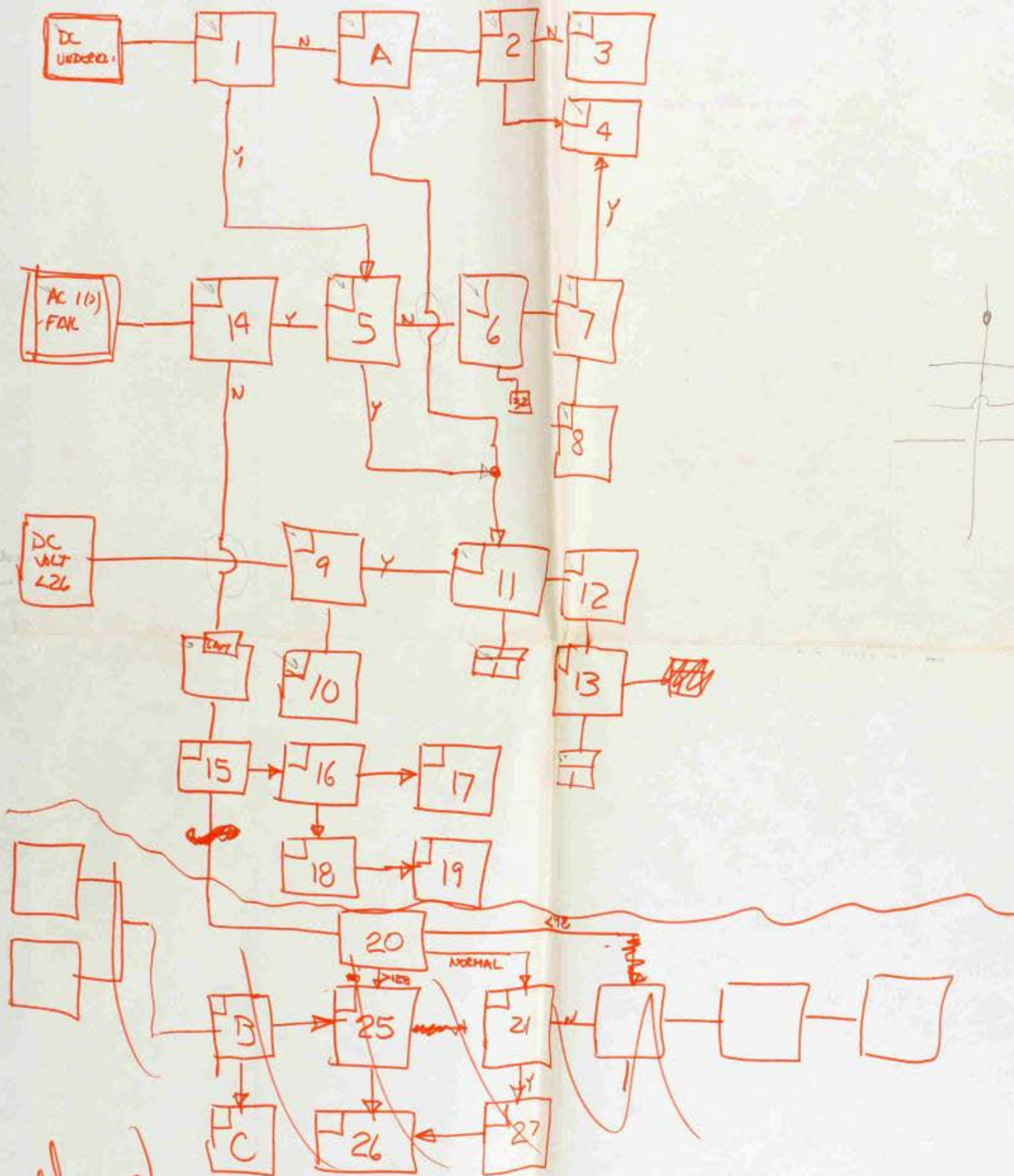
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Sept 23rd 1891

25

OK'd
500
RWC

W. H. Miller

Does Crystallinity decrease
significantly over
a time period?

SENSOR
FAILURE

15

Purge Valve
Leak or
Internal Pk
Leak

Magnitude of
Cryo usage determines
descent to shut
down PC

APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>1.0</p> <p>PC 1000000 PC 1000000 PC 1000000</p> <p>OK 500k</p> <p>CAUTION! Purges could cause a backfire in pressure and PLK flooding</p>	<p>1.0</p> <p>1. ON 1000000 RTV 003 H. 000000</p> <p>2. ON 1000000 RTV 003 H. 000000</p> <p>3. ON 1000000 RTV 003 H. 000000</p> <p>4. ON 1000000 RTV 003 H. 000000</p> <p>5. ON 1000000 RTV 003 H. 000000</p> <p>6. ON 1000000 RTV 003 H. 000000</p> <p>7. ON 1000000 RTV 003 H. 000000</p> <p>8. ON 1000000 RTV 003 H. 000000</p> <p>9. ON 1000000 RTV 003 H. 000000</p> <p>10. ON 1000000 RTV 003 H. 000000</p>	<p>1. Looking in most probable failure mode</p> <p>2. If Resistor AP (m N₂) decreases to — psi, shut down T/C</p>
<p>1.0</p> <p>PC 1000000 PC 1000000 PC 1000000</p> <p>How about O₂ purge?</p> <p>These steps need reviewing & consolidating</p>	<p>1.0</p> <p>1. ON 1000000 RTV 003 H. 000000</p> <p>2. ON 1000000 RTV 003 H. 000000</p> <p>3. ON 1000000 RTV 003 H. 000000</p> <p>4. ON 1000000 RTV 003 H. 000000</p> <p>5. ON 1000000 RTV 003 H. 000000</p> <p>6. ON 1000000 RTV 003 H. 000000</p> <p>7. ON 1000000 RTV 003 H. 000000</p> <p>8. ON 1000000 RTV 003 H. 000000</p> <p>9. ON 1000000 RTV 003 H. 000000</p> <p>10. ON 1000000 RTV 003 H. 000000</p>	<p>1. ON 1000000 RTV 003 H. 000000</p> <p>2. ON 1000000 RTV 003 H. 000000</p> <p>3. ON 1000000 RTV 003 H. 000000</p> <p>4. ON 1000000 RTV 003 H. 000000</p> <p>5. ON 1000000 RTV 003 H. 000000</p> <p>6. ON 1000000 RTV 003 H. 000000</p> <p>7. ON 1000000 RTV 003 H. 000000</p> <p>8. ON 1000000 RTV 003 H. 000000</p> <p>9. ON 1000000 RTV 003 H. 000000</p> <p>10. ON 1000000 RTV 003 H. 000000</p>

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APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>1d</p> <p>FC 1(2/3) SKIN TEMP LOW $< 360^{\circ}\text{F}$</p>	<p>1.5</p> <p>1 OBSERVED TEMP COMPARED TO CALCULATED FC TEMP OR V-I CURVE?</p> <p>LOW</p> <p>2 SENSOR OR CONTROL FAILURE</p> <p>3 MONITOR V-I PERFORMANCE</p> <p>4 FC CURRENT DEGRAD</p> <p>5 FC HRTS OFF</p> <p>6 FC 1(2/3) HEATER SW OFF</p> <p>7 FC OPERATION MAY CONTINUE UNTIL TEMP $> 330^{\circ}\text{F}$ WITH DEGRADED OUTPUT</p> <p>8 FC INTERNAL FAILURE</p> <p>9 FC USABLE INCREASE TEMP BY INCREASING ELECT. LOAD</p> <p>10 FAILURE OF FC INLINE HEATER</p> <p>11 FC USABLE MAINTAIN CURRENT > 20 AMPS</p> <p>12 SHUTDOWN</p>	
<p>1e</p> <p>FC MOD TEMP COND ENH HIGH $> 175^{\circ}\text{F}$</p>	<p>1.6</p> <p>1 FC PRO ENH NORMAL</p> <p>2 SET RAD SW</p> <p>3 FC 1(2/3) RAD SW - NORM (INDICATOR) TO RETAIN TO NORM</p> <p>4 TEST REJECTION EXCEEDS FC LOADS</p> <p>5 DECREASE ELECT. LOADS</p> <p>6 FLOW RESTRICTION OR COOLANT PUMP DECREASED OUTPUT</p> <p>7 INCREASE FLOW LOAD OR PUMP CURRENT</p> <p>8 TEST REJECTION EXCEEDS FC LOADS</p> <p>9 DECREASE ELECT. LOADS</p> <p>10 TEMP INCREASE WITHIN 15 MIN?</p> <p>11 SLOWLY INCREASE FLOW LOAD OR PUMP CURRENT</p> <p>12 DECREASE ELECT. LOADS OR RAD. OUT TEMP</p> <p>13 RAD OUT AND RAD IN TEMPS TEND TO CONVERGE?</p> <p>14 COOLANT PUMP FAILURE</p> <p>15 FC PRESERVATION DESIRABLE?</p> <p>16 FC 1(2/3) HEATER SW OFF</p> <p>17 FC 1(2/3) HEATER SW OFF</p> <p>18 FC 1(2/3) HEATER SW OFF</p> <p>19 FC 1(2/3) HEATER SW OFF</p> <p>20 FC 1(2/3) HEATER SW OFF</p> <p>21 FC 1(2/3) HEATER SW OFF</p> <p>22 FC 1(2/3) HEATER SW OFF</p> <p>23 FC 1(2/3) HEATER SW OFF</p> <p>24 FC 1(2/3) HEATER SW OFF</p> <p>25 FC 1(2/3) HEATER SW OFF</p> <p>26 FC 1(2/3) HEATER SW OFF</p> <p>27 FC 1(2/3) HEATER SW OFF</p> <p>28 FC 1(2/3) HEATER SW OFF</p> <p>29 FC 1(2/3) HEATER SW OFF</p> <p>30 FC 1(2/3) HEATER SW OFF</p> <p>31 FC 1(2/3) HEATER SW OFF</p> <p>32 FC 1(2/3) HEATER SW OFF</p> <p>33 FC 1(2/3) HEATER SW OFF</p> <p>34 FC 1(2/3) HEATER SW OFF</p> <p>35 FC 1(2/3) HEATER SW OFF</p> <p>36 FC 1(2/3) HEATER SW OFF</p> <p>37 FC 1(2/3) HEATER SW OFF</p> <p>38 FC 1(2/3) HEATER SW OFF</p> <p>39 FC 1(2/3) HEATER SW OFF</p> <p>40 FC 1(2/3) HEATER SW OFF</p> <p>41 FC 1(2/3) HEATER SW OFF</p> <p>42 FC 1(2/3) HEATER SW OFF</p> <p>43 FC 1(2/3) HEATER SW OFF</p> <p>44 FC 1(2/3) HEATER SW OFF</p> <p>45 FC 1(2/3) HEATER SW OFF</p> <p>46 FC 1(2/3) HEATER SW OFF</p> <p>47 FC 1(2/3) HEATER SW OFF</p> <p>48 FC 1(2/3) HEATER SW OFF</p> <p>49 FC 1(2/3) HEATER SW OFF</p> <p>50 FC 1(2/3) HEATER SW OFF</p> <p>51 FC 1(2/3) HEATER SW OFF</p> <p>52 FC 1(2/3) HEATER SW OFF</p> <p>53 FC 1(2/3) HEATER SW OFF</p> <p>54 FC 1(2/3) HEATER SW OFF</p> <p>55 FC 1(2/3) HEATER SW OFF</p> <p>56 FC 1(2/3) HEATER SW OFF</p> <p>57 FC 1(2/3) HEATER SW OFF</p> <p>58 FC 1(2/3) HEATER SW OFF</p> <p>59 FC 1(2/3) HEATER SW OFF</p> <p>60 FC 1(2/3) HEATER SW OFF</p> <p>61 FC 1(2/3) HEATER SW OFF</p> <p>62 FC 1(2/3) HEATER SW OFF</p> <p>63 FC 1(2/3) HEATER SW OFF</p> <p>64 FC 1(2/3) HEATER SW OFF</p> <p>65 FC 1(2/3) HEATER SW OFF</p> <p>66 FC 1(2/3) HEATER SW OFF</p> <p>67 FC 1(2/3) HEATER SW OFF</p> <p>68 FC 1(2/3) HEATER SW OFF</p> <p>69 FC 1(2/3) HEATER SW OFF</p> <p>70 FC 1(2/3) HEATER SW OFF</p> <p>71 FC 1(2/3) HEATER SW OFF</p> <p>72 FC 1(2/3) HEATER SW OFF</p> <p>73 FC 1(2/3) HEATER SW OFF</p> <p>74 FC 1(2/3) HEATER SW OFF</p> <p>75 FC 1(2/3) HEATER SW OFF</p> <p>76 FC 1(2/3) HEATER SW OFF</p> <p>77 FC 1(2/3) HEATER SW OFF</p> <p>78 FC 1(2/3) HEATER SW OFF</p> <p>79 FC 1(2/3) HEATER SW OFF</p> <p>80 FC 1(2/3) HEATER SW OFF</p> <p>81 FC 1(2/3) HEATER SW OFF</p> <p>82 FC 1(2/3) HEATER SW OFF</p> <p>83 FC 1(2/3) HEATER SW OFF</p> <p>84 FC 1(2/3) HEATER SW OFF</p> <p>85 FC 1(2/3) HEATER SW OFF</p> <p>86 FC 1(2/3) HEATER SW OFF</p> <p>87 FC 1(2/3) HEATER SW OFF</p> <p>88 FC 1(2/3) HEATER SW OFF</p> <p>89 FC 1(2/3) HEATER SW OFF</p> <p>90 FC 1(2/3) HEATER SW OFF</p> <p>91 FC 1(2/3) HEATER SW OFF</p> <p>92 FC 1(2/3) HEATER SW OFF</p> <p>93 FC 1(2/3) HEATER SW OFF</p> <p>94 FC 1(2/3) HEATER SW OFF</p> <p>95 FC 1(2/3) HEATER SW OFF</p> <p>96 FC 1(2/3) HEATER SW OFF</p> <p>97 FC 1(2/3) HEATER SW OFF</p> <p>98 FC 1(2/3) HEATER SW OFF</p> <p>99 FC 1(2/3) HEATER SW OFF</p> <p>100 FC 1(2/3) HEATER SW OFF</p>	<p>① RADIATOR IN TEMP MUST BE OBTAINED FROM M.S.P.N.</p> <p>② If possible, He purge the water should be on 30 min purg to purge</p> <p>Heat in note in 100 1000s</p>

APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
18 FC RAD TEMP CAND EXN LOW <155°F	<p>① F/C PUMP AC CB.</p> <p>OPDU</p> <p>FC</p> <p>FC CIRCUIT SEP CB OPEN</p> <p>CLOSED</p> <p>2 FC MOD SKIN TEMP TEMP HIGH AND/OR RISING 35-40°F/HR?</p> <p>YES</p> <p>3 FIC 4E PUMP OPEN CIRCUIT FAILURE</p> <p>4 • FK HEATING 1(2,3) SEE • FIC PUMP 1(2,3) OFF • MAINTAIN TSKN 4500° BY POSING REDUCED LOADS OR OPEN CIRCUIT AND > 380 BY PLACING FIC ON LOAD</p> <p>5 IS V-I PERFORM NORMAL AND COMPATIBLE WITH OTHER FIC'S?</p> <p>NO</p> <p>FC</p> <p>3 1</p> <p>PERFORMANCE LOW</p> <p>6 SPD TEST SELECT 3B, 3C, 3D RAD OUT TEMP TEMP < -30°F?</p> <p>YES</p> <p>7 • INCREASE FK LOAD • ORIENT FIC FOR HEATING</p> <p>8 Does TSKN follow T_{SKN} decrease in ~30 minutes? or Does TSKN show greater cyclical variations than other FIC's over orbital periods?</p> <p>YES</p> <p>9 COOLANT BY-PASS VALVE FAILURE IN BY-PASS POSITION</p> <p>10 Maintain FIC TSKN by increased loads and/or online heater operation</p> <p>NO</p> <p>11 SENSOR FAILURE</p>	<p>① If possible, the purge line heaters should be turned on 30 min prior to purging. Without the pump, inline heater will burn out if used. Do not use inline heater</p> <p>② Since continued operation with rad out temp < -30°F may result in radiator freezing, consideration can be given to radiator bypass. However this process may be an unrecoverable action.</p> <p>③ Orbital temperature effects may mask TSKN changes.</p> <p>④ This isolated symptom will not rapidly degrade FIC. Sufficient diagnostic time is available before action is required.</p> <p>⑤ FIC may be operable for remainder of mission. Performance changes can be expected due to possible electrolyte dehydration. Voltage should be maintained < 1400V and rad out temp > -30°F</p>
19 FC-1(2,3) W-HIGH T2-37	<p>18</p> <p>1 CURRENT FC-1(2,3) DECREASING OR NEAR ZERO?</p> <p>YES</p> <p>2 3-STEP • 1-STEP IN (AUX) NO OR PRESS OUT?</p> <p>NO</p> <p>3 3-STEP • 1-STEP IN (AUX) NO OR PRESS OUT?</p> <p>YES</p> <p>4 3-STEP FAILURE</p> <p>5 USE BACK- UP PERFORM DETERMINING IF MONITOR FC PERFORM- ANCE AND REG OUT PRESS.</p> <p>6 FC FAILURE</p> <p>7C A 1</p> <p>8 STOP DOWN</p>	<p>① CAUTION DO NOT PURGE FC IF FLOODING IS SUSP- ECTED. PLUMBING OR COMMON VENT LINE MAY RESULT</p> <p>② WARNING CONTINUED OPERATION MAY CONTAMINATE WATER SUPPLY</p>

G&N MALFUNCTION

SCS MALFUNCTION

SPS MALFUNCTION

RCS MALFUNCTION

EPS MALFUNCTION

T/C MALFUNCTION

ECS MALFUNCTION

SEQ MALFUNCTION

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SYMPTOM	PROCEDURE	REMARKS	G&N	SCS	SPS	RCS	EPS	T/C	ECS	SEQ
<p>1h</p> <p>FC REG OUT PRESS. N₂ HIGH TB-8P > 20 PSI/A</p>		<p>① H₂O₂ REGULATORS ARE ASSOCIATED TO H₂ REGULATORS. IF PRESS. HI WITHOUT H₂ AND O₂ HI INDICATES NO INTERIMINATION OF CWS BY FAILURE.</p> <p>② IF OUTPUT OF FC IS LOW LB PRESS. RISING DUE TO INTERNAL FC PRESS. FLUCTUATION PROBABLE.</p> <p>③ FAILURE OF N₂ REGULATOR WILL RAISE TB-8P AND N₂ PRESS. BUT NOT DIFFERENTIALLY. FC SHOULD CONTINUE TO OPERATE AT NEW PRESS. WITH SLIGHT PERFORMANCE CHANGE. NEXT T/R GSK WILL NOT BE AFFECTED BY INCREASE IN ACCUMULATOR PRESS.</p>								
<p>1i</p> <p>FC REG OUT PRESS. H₂(O) HIGH TB-8P > 75 PSI/A</p>		<p>① ACTUAL H₂(O) REG. PRESS. OUT AVAILABLE ON SYSTEMS TEST. HIGH FLOW MAY BE ASSOCIATED WITH REGULATOR FAILURE.</p>								

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SYMPTOM	PROCEDURE	REMARKS	SEQ	ECS	T/C	EPS	R/S	SPS	SCS	G&N
1. FC INAD-TEMP LOW TO 200 TCE AND TCE 200°F	<p>10</p> <p>1 TCE AND TCE 200°F</p> <p>2 TCE 200°F</p> <p>3 TCE 200°F</p> <p>4 COMPARE RAD OUT TEMPS. > 200°F TEST SW. 20 30 20</p> <p>5 ARE ALL TEMPS LOW?</p> <p>6 FC USABLE</p> <p>7 EXHAUST RETENTION EXCESSIVE FOR 100% LOAD</p> <p>8 EXHAUST RAD PANEL 8 TONNED SW. INCREASE ELECT LOADS OVERNIGHT TO CORRECT</p>	<p>③ DIFFERENTIATE BY VERIFICATION TEMP. WITH MSFN.</p>								
2. FC 1(2,3) CURSES P. MOTORS (35 OPEN)	<p>1 ATTEMPT RESET</p> <p>2 FC 1(2,3) PUMPS - AC CB-LOCK</p> <p>3 FC 1(2,3) PUMPS - AC CB-LOCK</p> <p>4 FC 1(2,3) PUMPS - AC CB-LOCK</p> <p>5 FC COOLING CAN BE MAINTAINED BY OPER. CRT. OPERATION AND/OR CONTINUOUS H₂ PURGE</p>	<p>① This condition will result in Low Cool Cbk for high TCE</p> <p>② FC INLINE HEATER WILL CONSUME ELECTRICAL POWER WITHOUT BEING ABLE TO DISPERSE ANY HEAT. AFTER EXTENDED INLINE HEATER OPERATION UNDER THESE CONDITIONS, HEATER ELEMENT WILL FAIL.</p> <p>③ TO KEEP FC IN RESERVE, MAINTAIN TCE > 2375°F BY PERIODIC OPERATION ON ELECTRICAL LOAD. PLAN TO USE WITH CONTINUOUS H₂ PURGE ANY TIME FC IS USED. FLOW METER LIMITS WILL BE EXCEEDED DURING PURGE OPERATION, THEREFORE AN H₂ CONSUMPTION OF 0.7 TON SHOULD BE USED FOR PUMPING & PURGE.</p>								

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SYMPTOM	PROCEDURE	REMARKS
3. FC (1,2,3) VI FEEDBACK POWER LOW	<p>1. POWER RST</p> <ul style="list-style-type: none"> • FC (1,2,3) HTE SW-24, 10 • FC (1,2,3) HTE SW-25, 10 • FC (1,2,3) HTE SW-26, 10 • FC (1,2,3) HTE SW-27, 10 • FC (1,2,3) HTE SW-28, 10 • FC (1,2,3) HTE SW-29, 10 • FC (1,2,3) HTE SW-30, 10 • FC (1,2,3) HTE SW-31, 10 • FC (1,2,3) HTE SW-32, 10 • FC (1,2,3) HTE SW-33, 10 • FC (1,2,3) HTE SW-34, 10 • FC (1,2,3) HTE SW-35, 10 • FC (1,2,3) HTE SW-36, 10 • FC (1,2,3) HTE SW-37, 10 • FC (1,2,3) HTE SW-38, 10 • FC (1,2,3) HTE SW-39, 10 • FC (1,2,3) HTE SW-40, 10 • FC (1,2,3) HTE SW-41, 10 • FC (1,2,3) HTE SW-42, 10 • FC (1,2,3) HTE SW-43, 10 • FC (1,2,3) HTE SW-44, 10 • FC (1,2,3) HTE SW-45, 10 • FC (1,2,3) HTE SW-46, 10 • FC (1,2,3) HTE SW-47, 10 • FC (1,2,3) HTE SW-48, 10 • FC (1,2,3) HTE SW-49, 10 • FC (1,2,3) HTE SW-50, 10 • FC (1,2,3) HTE SW-51, 10 • FC (1,2,3) HTE SW-52, 10 • FC (1,2,3) HTE SW-53, 10 • FC (1,2,3) HTE SW-54, 10 • FC (1,2,3) HTE SW-55, 10 • FC (1,2,3) HTE SW-56, 10 • FC (1,2,3) HTE SW-57, 10 • FC (1,2,3) HTE SW-58, 10 • FC (1,2,3) HTE SW-59, 10 • FC (1,2,3) HTE SW-60, 10 • FC (1,2,3) HTE SW-61, 10 • FC (1,2,3) HTE SW-62, 10 • FC (1,2,3) HTE SW-63, 10 • FC (1,2,3) HTE SW-64, 10 • FC (1,2,3) HTE SW-65, 10 • FC (1,2,3) HTE SW-66, 10 • FC (1,2,3) HTE SW-67, 10 • FC (1,2,3) HTE SW-68, 10 • FC (1,2,3) HTE SW-69, 10 • FC (1,2,3) HTE SW-70, 10 • FC (1,2,3) HTE SW-71, 10 • FC (1,2,3) HTE SW-72, 10 • FC (1,2,3) HTE SW-73, 10 • FC (1,2,3) HTE SW-74, 10 • FC (1,2,3) HTE SW-75, 10 • FC (1,2,3) HTE SW-76, 10 • FC (1,2,3) HTE SW-77, 10 • FC (1,2,3) HTE SW-78, 10 • FC (1,2,3) HTE SW-79, 10 • FC (1,2,3) HTE SW-80, 10 • FC (1,2,3) HTE SW-81, 10 • FC (1,2,3) HTE SW-82, 10 • FC (1,2,3) HTE SW-83, 10 • FC (1,2,3) HTE SW-84, 10 • FC (1,2,3) HTE SW-85, 10 • FC (1,2,3) HTE SW-86, 10 • FC (1,2,3) HTE SW-87, 10 • FC (1,2,3) HTE SW-88, 10 • FC (1,2,3) HTE SW-89, 10 • FC (1,2,3) HTE SW-90, 10 • FC (1,2,3) HTE SW-91, 10 • FC (1,2,3) HTE SW-92, 10 • FC (1,2,3) HTE SW-93, 10 • FC (1,2,3) HTE SW-94, 10 • FC (1,2,3) HTE SW-95, 10 • FC (1,2,3) HTE SW-96, 10 • FC (1,2,3) HTE SW-97, 10 • FC (1,2,3) HTE SW-98, 10 • FC (1,2,3) HTE SW-99, 10 • FC (1,2,3) HTE SW-100, 10 <p>2. CONTINUE FC OPERATION</p> <p>3. CONTINUE FC OPERATION</p> <p>4. OPEN CYCLE</p> <p>5. PROBLEM SOLVED</p> <p>6. CONTINUE FC OPERATION</p> <p>7. INTERNAL FC PROBLEM</p> <p>8. CONTINUE FC OPERATION</p> <p>9. CONTINUE FC OPERATION</p> <p>10. CONTINUE FC OPERATION</p> <p>11. CONTINUE FC OPERATION</p> <p>12. CONTINUE FC OPERATION</p> <p>13. CONTINUE FC OPERATION</p> <p>14. CONTINUE FC OPERATION</p> <p>15. CONTINUE FC OPERATION</p> <p>16. CONTINUE FC OPERATION</p> <p>17. CONTINUE FC OPERATION</p> <p>18. CONTINUE FC OPERATION</p> <p>19. CONTINUE FC OPERATION</p> <p>20. CONTINUE FC OPERATION</p> <p>21. CONTINUE FC OPERATION</p> <p>22. CONTINUE FC OPERATION</p> <p>23. CONTINUE FC OPERATION</p> <p>24. CONTINUE FC OPERATION</p> <p>25. CONTINUE FC OPERATION</p> <p>26. CONTINUE FC OPERATION</p> <p>27. CONTINUE FC OPERATION</p> <p>28. CONTINUE FC OPERATION</p> <p>29. CONTINUE FC OPERATION</p> <p>30. CONTINUE FC OPERATION</p> <p>31. CONTINUE FC OPERATION</p> <p>32. CONTINUE FC OPERATION</p> <p>33. 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4. FC SHUTDOWN	<p>1. CONFIRM FC SHUTDOWN</p> <p>2. CONFIRM FC SHUTDOWN</p> <p>3. CONFIRM FC SHUTDOWN</p> <p>4. CONFIRM FC SHUTDOWN</p> <p>5. CONFIRM FC SHUTDOWN</p> <p>6. CONFIRM FC SHUTDOWN</p> <p>7. CONFIRM FC SHUTDOWN</p> <p>8. CONFIRM FC SHUTDOWN</p> <p>9. CONFIRM FC SHUTDOWN</p> <p>10. CONFIRM FC SHUTDOWN</p> <p>11. CONFIRM FC SHUTDOWN</p> <p>12. CONFIRM FC SHUTDOWN</p> <p>13. CONFIRM FC SHUTDOWN</p> <p>14. CONFIRM FC SHUTDOWN</p> <p>15. CONFIRM FC SHUTDOWN</p> <p>16. CONFIRM FC SHUTDOWN</p> <p>17. CONFIRM FC SHUTDOWN</p> <p>18. CONFIRM FC SHUTDOWN</p> <p>19. CONFIRM FC SHUTDOWN</p> <p>20. CONFIRM FC SHUTDOWN</p> <p>21. CONFIRM FC SHUTDOWN</p> <p>22. CONFIRM FC SHUTDOWN</p> <p>23. CONFIRM FC SHUTDOWN</p> <p>24. CONFIRM FC SHUTDOWN</p> <p>25. CONFIRM FC SHUTDOWN</p> <p>26. CONFIRM FC SHUTDOWN</p> <p>27. CONFIRM FC SHUTDOWN</p> <p>28. CONFIRM FC SHUTDOWN</p> <p>29. CONFIRM FC SHUTDOWN</p> <p>30. CONFIRM FC SHUTDOWN</p> <p>31. CONFIRM FC SHUTDOWN</p> <p>32. CONFIRM FC SHUTDOWN</p> <p>33. CONFIRM FC SHUTDOWN</p> <p>34. CONFIRM FC SHUTDOWN</p> <p>35. CONFIRM FC SHUTDOWN</p> <p>36. CONFIRM FC SHUTDOWN</p> <p>37. CONFIRM FC SHUTDOWN</p> <p>38. CONFIRM FC SHUTDOWN</p> <p>39. CONFIRM FC SHUTDOWN</p> <p>40. CONFIRM FC SHUTDOWN</p> <p>41. CONFIRM FC SHUTDOWN</p> <p>42. CONFIRM FC SHUTDOWN</p> <p>43. CONFIRM FC SHUTDOWN</p> <p>44. CONFIRM FC SHUTDOWN</p> <p>45. CONFIRM FC SHUTDOWN</p> <p>46. CONFIRM FC SHUTDOWN</p> <p>47. CONFIRM FC SHUTDOWN</p> <p>48. CONFIRM FC SHUTDOWN</p> <p>49. CONFIRM FC SHUTDOWN</p> <p>50. CONFIRM FC SHUTDOWN</p> <p>51. CONFIRM FC SHUTDOWN</p> <p>52. CONFIRM FC SHUTDOWN</p> <p>53. CONFIRM FC SHUTDOWN</p> <p>54. CONFIRM FC SHUTDOWN</p> <p>55. CONFIRM FC SHUTDOWN</p> <p>56. CONFIRM FC SHUTDOWN</p> <p>57. CONFIRM FC SHUTDOWN</p> <p>58. CONFIRM FC SHUTDOWN</p> <p>59. CONFIRM FC SHUTDOWN</p> <p>60. CONFIRM FC SHUTDOWN</p> <p>61. CONFIRM FC SHUTDOWN</p> <p>62. CONFIRM FC SHUTDOWN</p> <p>63. CONFIRM FC SHUTDOWN</p> <p>64. CONFIRM FC SHUTDOWN</p> <p>65. CONFIRM FC SHUTDOWN</p> <p>66. CONFIRM FC SHUTDOWN</p> <p>67. CONFIRM FC SHUTDOWN</p> <p>68. CONFIRM FC SHUTDOWN</p> <p>69. CONFIRM FC SHUTDOWN</p> <p>70. CONFIRM FC SHUTDOWN</p> <p>71. CONFIRM FC SHUTDOWN</p> <p>72. CONFIRM FC SHUTDOWN</p> <p>73. CONFIRM FC SHUTDOWN</p> <p>74. CONFIRM FC SHUTDOWN</p> <p>75. CONFIRM FC SHUTDOWN</p> <p>76. CONFIRM FC SHUTDOWN</p> <p>77. CONFIRM FC SHUTDOWN</p> <p>78. CONFIRM FC SHUTDOWN</p> <p>79. CONFIRM FC SHUTDOWN</p> <p>80. CONFIRM FC SHUTDOWN</p> <p>81. CONFIRM FC SHUTDOWN</p> <p>82. CONFIRM FC SHUTDOWN</p> <p>83. CONFIRM FC SHUTDOWN</p> <p>84. CONFIRM FC SHUTDOWN</p> <p>85. CONFIRM FC SHUTDOWN</p> <p>86. CONFIRM FC SHUTDOWN</p> <p>87. CONFIRM FC SHUTDOWN</p> <p>88. CONFIRM FC SHUTDOWN</p> <p>89. CONFIRM FC SHUTDOWN</p> <p>90. CONFIRM FC SHUTDOWN</p> <p>91. CONFIRM FC SHUTDOWN</p> <p>92. CONFIRM FC SHUTDOWN</p> <p>93. CONFIRM FC SHUTDOWN</p> <p>94. CONFIRM FC SHUTDOWN</p> <p>95. CONFIRM FC SHUTDOWN</p> <p>96. CONFIRM FC SHUTDOWN</p> <p>97. CONFIRM FC SHUTDOWN</p> <p>98. CONFIRM FC SHUTDOWN</p> <p>99. CONFIRM FC SHUTDOWN</p> <p>100. CONFIRM FC SHUTDOWN</p>	<p>1. FC WILL NOT REACH TEMP. 200°F FOR APPROX. 24 HRS.</p> <p>2. PRESSURE IS REDUCED FROM KOL AT THIS TEMP. TO REDUCE POSSIBILITY OF <u>EXPLOSION</u> RESULTING WITH LIQUID KOH.</p>

G&N MALFUNCTION

SCS MALFUNCTION

SPS MALFUNCTION

RCS MALFUNCTION

EPS MALFUNCTION

T/C MALFUNCTION

ECS MALFUNCTION

SEQ MALFUNCTION

Basic Date

SEPT 10, 1967

Change Date

Page

7 of 7

FC
23 Sept
5 Oct

APOLLO OPERATIONS HANDBOOK

JACK

11 Oct 67
comments for final FLC
OK'd for pub
10-12-67

SYMPTOM	PROCEDURE	REMARKS
<p>1</p> <p>FC-1 (2,3)</p> <p>YELLOW</p> <p>UNIT (DOWN WHEN) DOWN MORE OF THE NINE MODES CHECK MANUALS ENCLOSURE ITS UNITS.</p>	<p>1. 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APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>1b</p> <p>FC 1(2,3) FLOW O₂(H₂) LOW</p> <p>O₂ < 0.14 w/h H₂ < 0.018 w/h</p>	<p>1-3 1-9</p> <p>1 FC FLOW O₂ IND. 3 TIMES FLOW H₂ IND.?</p> <p>YES (LOW) NO (LOW)</p> <p>2 FC PERFORMANCE NORMAL?</p> <p>YES NO</p> <p>3 FC FAILURE</p> <p>4 LOW ELECTRICAL LOAD</p> <p>5 OPEN EXT. FC • RECONFIGURE FC LOADS • FC OVAL (B) 1 (2,3) SW - OFF NOTE: FC SHUT DOWN MAY BE UNNECESSARY</p> <p>6 FC PERFORMANCE COMPARABLE TO V-I (SERV)?</p> <p>YES NO</p> <p>7 CHECK P₂(H₂) REGRESS • TEST SW'S 10 (P₂ H₂) 10 (SERV) PRESSURE OVER PERIOD OR TIME?</p> <p>YES NO</p> <p>8 BLOCKED REACTANT LINE</p> <p>9 MONITOR V-I TEMP AND REG OUT PRESS FOR DECISION TO CONT. FC OPERATION OR SHUT DOWN</p> <p>10 SENSOR FAILURE</p> <p>11 FC USABLE OTHER REACTANT INDICATOR MAY BE USED FOR AFFECTED FC INDICATION</p>	
<p>1c</p> <p>FC 1(2,3) MOD TEMP SKIN - HIGH > 500°F</p>	<p>15</p> <p>1 V-I PERF. NORMAL FOR OBSERVED TEMP?</p> <p>YES NO</p> <p>2 FC PERF. LOWER THAN OTHER FC'S</p> <p>YES NO</p> <p>3 EXTERNAL FAILURE PROBABLE</p> <p>4 SENSOR FAILURE</p> <p>5 CONTINUE FC OPERATION • MONITOR PERF., OTHER FC'S • LOCATION'S INDICATIVE</p> <p>6 PRIMARY BYPASS VALV FAILED IN REGENERATE POSITION</p> <p>CAUTION PFD. CHANGED OPER- ATION > 500°F WILL RESULT IN EVENTUAL FC FAILURE</p> <p>7 DECREASE SKIN TEMP • DECREASE ELECTRICAL LOADS OR OPEN EXT. FC. • PURGE FC</p> <p>8 H₂ PURGE • FC PURGE LINE HEAT SW - 2000 MIN. FOR PURGE (2,3) SW - OFF</p> <p>9 OPEN EXT. FC • RECONFIGURE FC LOADS • FC OVAL (B) 1 (2,3) SW - OFF</p> <p>10 FC 1(2,3) MOD TEMP SKIN - HIGH > 500°F</p>	<p>① OPEN CIRCUIT WILL RETAIN FC RESIDUAL CAPACITY THROUGH FC INLINE HEATERS, PREVENT- ING KOH SOLIDIFICATION. PURGING H₂ WILL TEND TO REDUCE FC TEMP. FOR PLANNING PURPOSES AN H₂ CONSUMPTION OF 0.9 PPH SHOULD BE USED BECAUSE OF PURGE.</p> <p>② H₂ PURGE LINE HEATER SHOULD BE ON 30 MIN. PRIOR TO PURGE. IF TEMP > 500°F THE HEATER IS NOT REQUIRED TO BE ON 30 MIN.</p> <p>③ IF FUEL LINE HEATER HEATER IS OFF FC HEATER SW OFF unless FIC is on open circuit.</p>

G&N
MALFUNCTION

SCS
MALFUNCTION

SPS
MALFUNCTION

RCS
MALFUNCTION

EPS
MALFUNCTION

T/C
MALFUNCTION

ECS
MALFUNCTION

SEQ
MALFUNCTION

APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
13 FC I(2,3) SKIN TEMP LOW 2360°F	<p>1. OBSERVED TEMP COMPARE TO CALCULATED FC TEMP OR V-I CURVE?</p> <p>2. LOWER → 3. MONITOR V-I PERFORMANCE</p> <p>4. HIGHER → 5. FC HEATER OFF</p> <p>6. FC INTERNAL FAILURE</p> <p>7. FC OPERATION MAY CONTINUE WITH TEMP 2330°F WITH DEGRADED OUTPUT</p> <p>8. FC CURRENT > 20A?</p> <p>9. YES → 10. FAILURE OF FC INLINE HEATER</p> <p>10. NO → 11. FC USABLE MAINTAIN CURRENT > 20 AMPS</p> <p>12. FC USABLE INCREASE TEMP BY INCREASING BEET LOAD</p>	G&N MALFUNCTION
14 FC MOD TEMP COND B-H HIGH >175°F	<p>1. 1.6</p> <p>2. 2.1 FC RAD IN NORMAL</p> <p>3. 2.2 SET RAD GNS</p> <p>4. 2.3 FC I(2,3) RAD IN NORM (INDIVIDUAL)</p> <p>5. 2.4 FC RETURN IS TO NORM?</p> <p>6. 2.5 CONTINUE FC OPERATION, MONITOR HEAT REJECTION CAPABILITY</p> <p>7. 2.6 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>8. 2.7 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>9. 2.8 FLOW RESTRICTION OR COOLANT PUMP DECREASED OUTPUT</p> <p>10. 2.9 DECREASE ELECT LOADS</p> <p>11. 2.10 COOLANT FLOW IN VESSEL (2.11)</p> <p>12. 2.11 INCREASE ELECT LOADS OR RAD OUT TEMP</p> <p>13. 2.12 FC RESERVATION DESIRED?</p> <p>14. 2.13 YES → 2.14 FC RESERVATION DESIRED?</p> <p>15. 2.14 NO → 2.15 FC RESERVATION DESIRED?</p> <p>16. 2.15 YES → 2.16 FC RESERVATION DESIRED?</p> <p>17. 2.16 YES → 2.17 FC RESERVATION DESIRED?</p> <p>18. 2.17 YES → 2.18 FC RESERVATION DESIRED?</p> <p>19. 2.18 YES → 2.19 FC RESERVATION DESIRED?</p> <p>20. 2.19 YES → 2.20 FC RESERVATION DESIRED?</p> <p>21. 2.20 YES → 2.21 FC RESERVATION DESIRED?</p> <p>22. 2.21 YES → 2.22 FC RESERVATION DESIRED?</p> <p>23. 2.22 YES → 2.23 FC RESERVATION DESIRED?</p> <p>24. 2.23 YES → 2.24 FC RESERVATION DESIRED?</p> <p>25. 2.24 YES → 2.25 FC RESERVATION DESIRED?</p> <p>26. 2.25 YES → 2.26 FC RESERVATION DESIRED?</p> <p>27. 2.26 YES → 2.27 FC RESERVATION DESIRED?</p> <p>28. 2.27 YES → 2.28 FC RESERVATION DESIRED?</p> <p>29. 2.28 YES → 2.29 FC RESERVATION DESIRED?</p> <p>30. 2.29 YES → 2.30 FC RESERVATION DESIRED?</p> <p>31. 2.30 YES → 2.31 FC RESERVATION DESIRED?</p> <p>32. 2.31 YES → 2.32 FC RESERVATION DESIRED?</p> <p>33. 2.32 YES → 2.33 FC RESERVATION DESIRED?</p> <p>34. 2.33 YES → 2.34 FC RESERVATION DESIRED?</p> <p>35. 2.34 YES → 2.35 FC RESERVATION DESIRED?</p> <p>36. 2.35 YES → 2.36 FC RESERVATION DESIRED?</p> <p>37. 2.36 YES → 2.37 FC RESERVATION DESIRED?</p> <p>38. 2.37 YES → 2.38 FC RESERVATION DESIRED?</p> <p>39. 2.38 YES → 2.39 FC RESERVATION DESIRED?</p> <p>40. 2.39 YES → 2.40 FC RESERVATION DESIRED?</p> <p>41. 2.40 YES → 2.41 FC RESERVATION DESIRED?</p> <p>42. 2.41 YES → 2.42 FC RESERVATION DESIRED?</p> <p>43. 2.42 YES → 2.43 FC RESERVATION DESIRED?</p> <p>44. 2.43 YES → 2.44 FC RESERVATION DESIRED?</p> <p>45. 2.44 YES → 2.45 FC RESERVATION DESIRED?</p> <p>46. 2.45 YES → 2.46 FC RESERVATION DESIRED?</p> <p>47. 2.46 YES → 2.47 FC RESERVATION DESIRED?</p> <p>48. 2.47 YES → 2.48 FC RESERVATION DESIRED?</p> <p>49. 2.48 YES → 2.49 FC RESERVATION DESIRED?</p> <p>50. 2.49 YES → 2.50 FC RESERVATION DESIRED?</p> <p>51. 2.50 YES → 2.51 FC RESERVATION DESIRED?</p> <p>52. 2.51 YES → 2.52 FC RESERVATION DESIRED?</p> <p>53. 2.52 YES → 2.53 FC RESERVATION DESIRED?</p> <p>54. 2.53 YES → 2.54 FC RESERVATION DESIRED?</p> <p>55. 2.54 YES → 2.55 FC RESERVATION DESIRED?</p> <p>56. 2.55 YES → 2.56 FC RESERVATION DESIRED?</p> <p>57. 2.56 YES → 2.57 FC RESERVATION DESIRED?</p> <p>58. 2.57 YES → 2.58 FC RESERVATION DESIRED?</p> <p>59. 2.58 YES → 2.59 FC RESERVATION DESIRED?</p> <p>60. 2.59 YES → 2.60 FC 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DESIRED?</p> <p>100. 2.99 YES → 3.00 FC RESERVATION DESIRED?</p>	RCS MALFUNCTION
15 FC MOD TEMP COND B-H HIGH >175°F	<p>1. 1.6</p> <p>2. 2.1 FC RAD IN NORMAL</p> <p>3. 2.2 SET RAD GNS</p> <p>4. 2.3 FC I(2,3) RAD IN NORM (INDIVIDUAL)</p> <p>5. 2.4 FC RETURN IS TO NORM?</p> <p>6. 2.5 CONTINUE FC OPERATION, MONITOR HEAT REJECTION CAPABILITY</p> <p>7. 2.6 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>8. 2.7 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>9. 2.8 FLOW RESTRICTION OR COOLANT PUMP DECREASED OUTPUT</p> <p>10. 2.9 DECREASE ELECT LOADS</p> <p>11. 2.10 COOLANT FLOW IN VESSEL (2.11)</p> <p>12. 2.11 INCREASE ELECT LOADS OR RAD OUT TEMP</p> <p>13. 2.12 FC RESERVATION DESIRED?</p> <p>14. 2.13 YES → 2.14 FC RESERVATION DESIRED?</p> <p>15. 2.14 NO → 2.15 FC RESERVATION DESIRED?</p> <p>16. 2.15 YES → 2.16 FC RESERVATION DESIRED?</p> <p>17. 2.16 YES → 2.17 FC RESERVATION DESIRED?</p> <p>18. 2.17 YES → 2.18 FC RESERVATION DESIRED?</p> <p>19. 2.18 YES → 2.19 FC RESERVATION DESIRED?</p> <p>20. 2.19 YES → 2.20 FC RESERVATION DESIRED?</p> <p>21. 2.20 YES → 2.21 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16 FC MOD TEMP COND B-H HIGH >175°F	<p>1. 1.6</p> <p>2. 2.1 FC RAD IN NORMAL</p> <p>3. 2.2 SET RAD GNS</p> <p>4. 2.3 FC I(2,3) RAD IN NORM (INDIVIDUAL)</p> <p>5. 2.4 FC RETURN IS TO NORM?</p> <p>6. 2.5 CONTINUE FC OPERATION, MONITOR HEAT REJECTION CAPABILITY</p> <p>7. 2.6 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>8. 2.7 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>9. 2.8 FLOW RESTRICTION OR COOLANT PUMP DECREASED OUTPUT</p> <p>10. 2.9 DECREASE ELECT LOADS</p> <p>11. 2.10 COOLANT FLOW IN VESSEL (2.11)</p> <p>12. 2.11 INCREASE ELECT LOADS OR RAD OUT TEMP</p> <p>13. 2.12 FC RESERVATION DESIRED?</p> <p>14. 2.13 YES → 2.14 FC RESERVATION DESIRED?</p> <p>15. 2.14 NO → 2.15 FC RESERVATION DESIRED?</p> <p>16. 2.15 YES → 2.16 FC RESERVATION DESIRED?</p> <p>17. 2.16 YES → 2.17 FC RESERVATION DESIRED?</p> <p>18. 2.17 YES → 2.18 FC RESERVATION DESIRED?</p> <p>19. 2.18 YES → 2.19 FC RESERVATION DESIRED?</p> <p>20. 2.19 YES → 2.20 FC RESERVATION DESIRED?</p> <p>21. 2.20 YES → 2.21 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<p>41. 2.40 YES → 2.41 FC RESERVATION DESIRED?</p> <p>42. 2.41 YES → 2.42 FC RESERVATION DESIRED?</p> <p>43. 2.42 YES → 2.43 FC RESERVATION DESIRED?</p> <p>44. 2.43 YES → 2.44 FC RESERVATION DESIRED?</p> <p>45. 2.44 YES → 2.45 FC RESERVATION DESIRED?</p> <p>46. 2.45 YES → 2.46 FC RESERVATION DESIRED?</p> <p>47. 2.46 YES → 2.47 FC RESERVATION DESIRED?</p> <p>48. 2.47 YES → 2.48 FC RESERVATION DESIRED?</p> <p>49. 2.48 YES → 2.49 FC RESERVATION DESIRED?</p> <p>50. 2.49 YES → 2.50 FC RESERVATION DESIRED?</p> <p>51. 2.50 YES → 2.51 FC RESERVATION DESIRED?</p> <p>52. 2.51 YES → 2.52 FC RESERVATION DESIRED?</p> <p>53. 2.52 YES → 2.53 FC RESERVATION DESIRED?</p> <p>54. 2.53 YES → 2.54 FC RESERVATION DESIRED?</p> <p>55. 2.54 YES → 2.55 FC RESERVATION DESIRED?</p> <p>56. 2.55 YES → 2.56 FC RESERVATION DESIRED?</p> <p>57. 2.56 YES → 2.57 FC RESERVATION DESIRED?</p> <p>58. 2.57 YES → 2.58 FC RESERVATION DESIRED?</p> <p>59. 2.58 YES → 2.59 FC RESERVATION DESIRED?</p> <p>60. 2.59 YES → 2.60 FC RESERVATION DESIRED?</p> <p>61. 2.60 YES → 2.61 FC RESERVATION DESIRED?</p> <p>62. 2.61 YES → 2.62 FC RESERVATION DESIRED?</p> <p>63. 2.62 YES → 2.63 FC RESERVATION DESIRED?</p> <p>64. 2.63 YES → 2.64 FC RESERVATION DESIRED?</p> <p>65. 2.64 YES → 2.65 FC RESERVATION DESIRED?</p> <p>66. 2.65 YES → 2.66 FC RESERVATION DESIRED?</p> <p>67. 2.66 YES → 2.67 FC RESERVATION DESIRED?</p> <p>68. 2.67 YES → 2.68 FC RESERVATION DESIRED?</p> <p>69. 2.68 YES → 2.69 FC RESERVATION DESIRED?</p> <p>70. 2.69 YES → 2.70 FC RESERVATION DESIRED?</p> <p>71. 2.70 YES → 2.71 FC RESERVATION DESIRED?</p> <p>72. 2.71 YES → 2.72 FC RESERVATION DESIRED?</p> <p>73. 2.72 YES → 2.73 FC RESERVATION DESIRED?</p> <p>74. 2.73 YES → 2.74 FC RESERVATION DESIRED?</p> <p>75. 2.74 YES → 2.75 FC RESERVATION DESIRED?</p> <p>76. 2.75 YES → 2.76 FC RESERVATION DESIRED?</p> <p>77. 2.76 YES → 2.77 FC RESERVATION DESIRED?</p> <p>78. 2.77 YES → 2.78 FC RESERVATION DESIRED?</p> <p>79. 2.78 YES → 2.79 FC RESERVATION DESIRED?</p> <p>80. 2.79 YES → 2.80 FC RESERVATION DESIRED?</p> <p>81. 2.80 YES → 2.81 FC RESERVATION DESIRED?</p> <p>82. 2.81 YES → 2.82 FC RESERVATION DESIRED?</p> <p>83. 2.82 YES → 2.83 FC RESERVATION DESIRED?</p> <p>84. 2.83 YES → 2.84 FC RESERVATION DESIRED?</p> <p>85. 2.84 YES → 2.85 FC RESERVATION DESIRED?</p> <p>86. 2.85 YES → 2.86 FC RESERVATION DESIRED?</p> <p>87. 2.86 YES → 2.87 FC RESERVATION DESIRED?</p> <p>88. 2.87 YES → 2.88 FC RESERVATION DESIRED?</p> <p>89. 2.88 YES → 2.89 FC RESERVATION DESIRED?</p> <p>90. 2.89 YES → 2.90 FC RESERVATION DESIRED?</p> <p>91. 2.90 YES → 2.91 FC RESERVATION DESIRED?</p> <p>92. 2.91 YES → 2.92 FC RESERVATION DESIRED?</p> <p>93. 2.92 YES → 2.93 FC RESERVATION DESIRED?</p> <p>94. 2.93 YES → 2.94 FC RESERVATION DESIRED?</p> <p>95. 2.94 YES → 2.95 FC RESERVATION DESIRED?</p> <p>96. 2.95 YES → 2.96 FC RESERVATION DESIRED?</p> <p>97. 2.96 YES → 2.97 FC RESERVATION DESIRED?</p> <p>98. 2.97 YES → 2.98 FC RESERVATION DESIRED?</p> <p>99. 2.98 YES → 2.99 FC RESERVATION DESIRED?</p> <p>100. 2.99 YES → 3.00 FC RESERVATION DESIRED?</p>	ECS MALFUNCTION
18 FC MOD TEMP COND B-H HIGH >175°F	<p>1. 1.6</p> <p>2. 2.1 FC RAD IN NORMAL</p> <p>3. 2.2 SET RAD GNS</p> <p>4. 2.3 FC I(2,3) RAD IN NORM (INDIVIDUAL)</p> <p>5. 2.4 FC RETURN IS TO NORM?</p> <p>6. 2.5 CONTINUE FC OPERATION, MONITOR HEAT REJECTION CAPABILITY</p> <p>7. 2.6 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>8. 2.7 INCREASE ELECT LOADS OR INCREASE STEADY STATE</p> <p>9. 2.8 FLOW RESTRICTION OR COOLANT PUMP DECREASED OUTPUT</p> <p>10. 2.9 DECREASE ELECT LOADS</p> <p>11. 2.10 COOLANT FLOW IN VESSEL (2.11)</p> <p>12. 2.11 INCREASE ELECT LOADS OR RAD OUT TEMP</p> <p>13. 2.12 FC RESERVATION DESIRED?</p> <p>14. 2.13 YES → 2.14 FC RESERVATION DESIRED?</p> <p>15. 2.14 NO → 2.15 FC RESERVATION DESIRED?</p> <p>16. 2.15 YES → 2.16 FC RESERVATION DESIRED?</p> <p>17. 2.16 YES → 2.17 FC RESERVATION DESIRED?</p> <p>18. 2.17 YES → 2.18 FC RESERVATION DESIRED?</p> <p>19. 2.18 YES → 2.19 FC RESERVATION DESIRED?</p> <p>20. 2.19 YES → 2.20 FC RESERVATION DESIRED?</p> <p>21. 2.20 YES → 2.21 FC RESERVATION DESIRED?</p> <p>22. 2.21 YES → 2.22 FC RESERVATION DESIRED?</p> <p>23. 2.22 YES → 2.23 FC RESERVATION DESIRED?</p> <p>24. 2.23 YES → 2.24 FC RESERVATION DESIRED?</p> <p>25. 2.24 YES → 2.25 FC RESERVATION DESIRED?</p> <p>26. 2.25 YES → 2.26 FC RESERVATION DESIRED?</p> <p>27. 2.26 YES → 2.27 FC RESERVATION DESIRED?</p> <p>28. 2.27 YES → 2.28 FC RESERVATION DESIRED?</p> <p>29. 2.28 YES → 2.29 FC RESERVATION DESIRED?</p> <p>30. 2.29 YES → 2.30 FC RESERVATION DESIRED?</p> <p>31. 2.30 YES → 2.31 FC RESERVATION DESIRED?</p> <p>32. 2.31 YES → 2.32 FC RESERVATION DESIRED?</p> <p>33. 2.32 YES → 2.33 FC RESERVATION DESIRED?</p> <p>34. 2.33 YES → 2.34 FC RESERVATION DESIRED?</p> <p>35. 2.34 YES → 2.35 FC RESERVATION DESIRED?</p> <p>36. 2.35 YES → 2.36 FC RESERVATION DESIRED?</p> <p>37. 2.36 YES → 2.37 FC RESERVATION DESIRED?</p> <p>38. 2.37 YES → 2.38 FC RESERVATION DESIRED?</p> <p>39. 2.38 YES → 2.39 FC RESERVATION DESIRED?</p> <p>40. 2.39 YES → 2.40 FC RESERVATION DESIRED?</p> <p>41. 2.40 YES → 2.41 FC RESERVATION DESIRED?</p> <p>42. 2.41 YES → 2.42 FC RESERVATION DESIRED?</p> <p>43. 2.42 YES → 2.43 FC RESERVATION DESIRED?</p> <p>44. 2.43 YES → 2.44 FC RESERVATION DESIRED?</p> <p>45. 2.44 YES → 2.45 FC RESERVATION DESIRED?</p> <p>46. 2.45 YES → 2.46 FC RESERVATION DESIRED?</p> <p>47. 2.46 YES → 2.47 FC RESERVATION DESIRED?</p> <p>48. 2.47 YES → 2.48 FC RESERVATION DESIRED?</p> <p>49. 2.48 YES → 2.49 FC RESERVATION DESIRED?</p> <p>50. 2.49 YES → 2.50 FC RESERVATION DESIRED?</p> <p>51. 2.50 YES → 2.51 FC RESERVATION DESIRED?</p> <p>52. 2.51 YES → 2.52 FC RESERVATION DESIRED?</p> <p>53. 2.52 YES → 2.53 FC RESERVATION DESIRED?</p> <p>54. 2.53 YES → 2.54 FC RESERVATION DESIRED?</p> <p>55. 2.54 YES → 2.55 FC RESERVATION DESIRED?</p> <p>56. 2.55 YES → 2.56 FC RESERVATION DESIRED?</p> <p>57. 2.56 YES → 2.57 FC RESERVATION DESI</p>	

APOLLO OPERATIONS HANDBOOK

[illegible]

SEQ MALFUNCTION	ECS MALFUNCTION	T/C MALFUNCTION	EPS MALFUNCTION	RCS MALFUNCTION	SPS MALFUNCTION	SCS MALFUNCTION	G&N MALFUNCTION
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APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS	SYMPTOM
1. FC RAD TEMP LOW TE-41 -30°F	<p>1. TCE AND Temp Normal?</p> <p>2. TCE AND Temp Normal?</p> <p>3. TCE AND Temp Normal?</p> <p>4. Compare rad out temps.</p> <p>5. TCE AND Temp Normal?</p> <p>6. TCE AND Temp Normal?</p> <p>7. TCE AND Temp Normal?</p> <p>8. TCE AND Temp Normal?</p> <p>9. TCE AND Temp Normal?</p> <p>10. TCE AND Temp Normal?</p> <p>11. TCE AND Temp Normal?</p> <p>12. TCE AND Temp Normal?</p> <p>13. TCE AND Temp Normal?</p> <p>14. TCE AND Temp Normal?</p> <p>15. TCE AND Temp Normal?</p> <p>16. TCE AND Temp Normal?</p> <p>17. TCE AND Temp Normal?</p> <p>18. TCE AND Temp Normal?</p> <p>19. TCE AND Temp Normal?</p> <p>20. TCE AND Temp Normal?</p> <p>21. TCE AND Temp Normal?</p> <p>22. TCE AND Temp Normal?</p> <p>23. TCE AND Temp Normal?</p> <p>24. TCE AND Temp Normal?</p> <p>25. TCE AND Temp Normal?</p> <p>26. TCE AND Temp Normal?</p> <p>27. TCE AND Temp Normal?</p> <p>28. TCE AND Temp Normal?</p> <p>29. TCE AND Temp Normal?</p> <p>30. TCE AND Temp Normal?</p> <p>31. TCE AND Temp Normal?</p> <p>32. TCE AND Temp Normal?</p> <p>33. TCE AND Temp Normal?</p> <p>34. TCE AND Temp Normal?</p> <p>35. TCE AND Temp Normal?</p> <p>36. TCE AND Temp Normal?</p> <p>37. TCE AND Temp Normal?</p> <p>38. TCE AND Temp Normal?</p> <p>39. TCE AND Temp Normal?</p> <p>40. TCE AND Temp Normal?</p> <p>41. TCE AND Temp Normal?</p> <p>42. TCE AND Temp Normal?</p> <p>43. TCE AND Temp Normal?</p> <p>44. TCE AND Temp Normal?</p> <p>45. TCE AND Temp Normal?</p> <p>46. TCE AND Temp Normal?</p> <p>47. TCE AND Temp Normal?</p> <p>48. TCE AND Temp Normal?</p> <p>49. TCE AND Temp Normal?</p> <p>50. TCE AND Temp Normal?</p> <p>51. TCE AND Temp Normal?</p> <p>52. TCE AND Temp Normal?</p> <p>53. TCE AND Temp Normal?</p> <p>54. TCE AND Temp Normal?</p> <p>55. TCE AND Temp Normal?</p> <p>56. TCE AND Temp Normal?</p> <p>57. TCE AND Temp Normal?</p> <p>58. TCE AND Temp Normal?</p> <p>59. TCE AND Temp Normal?</p> <p>60. TCE AND Temp Normal?</p> <p>61. TCE AND Temp Normal?</p> <p>62. TCE AND Temp Normal?</p> <p>63. TCE AND Temp Normal?</p> <p>64. TCE AND Temp Normal?</p> <p>65. TCE AND Temp Normal?</p> <p>66. TCE AND Temp Normal?</p> <p>67. TCE AND Temp Normal?</p> <p>68. TCE AND Temp Normal?</p> <p>69. TCE AND Temp Normal?</p> <p>70. TCE AND Temp Normal?</p> <p>71. TCE AND Temp Normal?</p> <p>72. TCE AND Temp Normal?</p> <p>73. TCE AND Temp Normal?</p> <p>74. TCE AND Temp Normal?</p> <p>75. TCE AND Temp Normal?</p> <p>76. TCE AND Temp Normal?</p> <p>77. TCE AND Temp Normal?</p> <p>78. TCE AND Temp Normal?</p> <p>79. TCE AND Temp Normal?</p> <p>80. TCE AND Temp Normal?</p> <p>81. TCE AND Temp Normal?</p> <p>82. TCE AND Temp Normal?</p> <p>83. TCE AND Temp Normal?</p> <p>84. TCE AND Temp Normal?</p> <p>85. TCE AND Temp Normal?</p> <p>86. TCE AND Temp Normal?</p> <p>87. TCE AND Temp Normal?</p> <p>88. TCE AND Temp Normal?</p> <p>89. TCE AND Temp Normal?</p> <p>90. TCE AND Temp Normal?</p> <p>91. TCE AND Temp Normal?</p> <p>92. TCE AND Temp Normal?</p> <p>93. TCE AND Temp Normal?</p> <p>94. TCE AND Temp Normal?</p> <p>95. TCE AND Temp Normal?</p> <p>96. TCE AND Temp Normal?</p> <p>97. TCE AND Temp Normal?</p> <p>98. TCE AND Temp Normal?</p> <p>99. TCE AND Temp Normal?</p> <p>100. TCE AND Temp Normal?</p>	<p>1. DIFFERENT TYPE BY VERIFICATION TEMP WITH MSFN.</p>	G&N MALFUNCTION
2. FC 1(2,3) CIRCUITRY MOTOR 5 CB OPEN	<p>1. ATTEMPT RESET</p> <p>2. ATTEMPT RESET</p> <p>3. ATTEMPT RESET</p> <p>4. ATTEMPT RESET</p> <p>5. ATTEMPT RESET</p> <p>6. ATTEMPT RESET</p> <p>7. ATTEMPT RESET</p> <p>8. ATTEMPT RESET</p> <p>9. ATTEMPT RESET</p> <p>10. ATTEMPT RESET</p> <p>11. ATTEMPT RESET</p> <p>12. ATTEMPT RESET</p> <p>13. ATTEMPT RESET</p> <p>14. ATTEMPT RESET</p> <p>15. ATTEMPT RESET</p> <p>16. ATTEMPT RESET</p> <p>17. ATTEMPT RESET</p> <p>18. ATTEMPT RESET</p> <p>19. ATTEMPT RESET</p> <p>20. ATTEMPT RESET</p> <p>21. ATTEMPT RESET</p> <p>22. ATTEMPT RESET</p> <p>23. ATTEMPT RESET</p> <p>24. ATTEMPT RESET</p> <p>25. ATTEMPT RESET</p> <p>26. ATTEMPT RESET</p> <p>27. ATTEMPT RESET</p> <p>28. ATTEMPT RESET</p> <p>29. ATTEMPT RESET</p> <p>30. ATTEMPT RESET</p> <p>31. ATTEMPT RESET</p> <p>32. ATTEMPT RESET</p> <p>33. ATTEMPT RESET</p> <p>34. ATTEMPT RESET</p> <p>35. ATTEMPT RESET</p> <p>36. ATTEMPT RESET</p> <p>37. ATTEMPT RESET</p> <p>38. ATTEMPT RESET</p> <p>39. 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This condition</p> <p>95. This condition</p> <p>96. This condition</p> <p>97. This condition</p> <p>98. This condition</p> <p>99. This condition</p> <p>100. This condition</p>	<p>RCS MALFUNCTION</p> <p>EPS MALFUNCTION</p> <p>T/C MALFUNCTION</p> <p>ECS MALFUNCTION</p> <p>SEQ MALFUNCTION</p>

Basic Date SEP 12, 1967

Change Date

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APOLLO OPERATIONS HANDBOOK

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FC
paid 15 Sept
received 10 Oct
(See 50ct for

FC
IT

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FC
1a

,

FC
1b

)

FC SHUTDOWN CHANGES

Box 2 should read

2

- FC 1(2,3) REACS CB - CLOSED
- FC 1,(2,3) PURGE CB - OPEN
- FC HTR 1(2,3) SW - OFF
- FC PUMP 1(2,3) SW - OFF
- FC PUMP 1(2,3) CB - OPEN

NOTE: IF FC 1 or 3
FC PUMP SW MUST BE RETURNED
TO ON TO ENABLE POWER
FACTOR CORRECTION

REMARK ④

THE WORD "ADDITIONAL" SHOULD
BE DELETED.

(Since we are shutting down
the fuel cell we do not care
whether KOH corrodes the H₂ pump.)